

REMARKS

Applicant respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow.

Claims 3-4, 12 and 13 are currently being amended. Claim 5 is cancelled without prejudice. No new matter is added.

This amendment changes claims in this application. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier.

After amending the claims as set forth above, claims 1-4 and 6-23 are now pending in this application.

Withdrawal of Finality of Rejection

Despite Applicants amending the independent claims to include elements from dependent claims in Applicants' response to the previous Office Action, this Office Action was made final. MPEP 706.7(a) indicates that:

Under present practice, second or any subsequent actions on the merits shall be final, except where the examiner introduces a new ground of rejection that is neither necessitated by applicant's amendment of the claims nor based on information submitted in an information disclosure statement filed during the period set forth in 37 CFR 1.97(c) with the fee set forth in 37 CFR 1.17(p).

Here, the Examiner has entered a new ground of rejection. However, this new ground of rejection is not necessitated by Applicants' amendment because Applicants only incorporated dependent claims into independent claims in the previous response. Further, this new ground of rejection is not necessitated by information submitted in an IDS because such an IDS was not entered with the previous response. Accordingly, Applicants respectfully request withdrawal of the finality of the rejection.

Claim Objections

In Paragraph 1 of the Office Action, claims 3-4, 5, 12 and 13 were objected to based on various informalities. These informalities have been corrected by amendment herein. Applicants respectfully request withdrawal of the objections.

Claim Rejections under 35 U.S.C. 103

Claims 1-9:

In Paragraphs 3-8 of the Office Action, Claims 1 – 9 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,030,895 (“Joshi”) in view of U.S. Patent No. 6,339,496 (“Edelstein”), U.S. Patent No. 5,243,222 (“Harper”), and “Improving Copper Interconnects: A Search for Useful Dopants,” Semiconductor International, April 2000, pp. 1-8 (“Cunningham”). Applicants respectfully traverse rejection.

Joshi does not disclose or suggest “depositing a copper alloy via material in the via aperture to form a via, the copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)” as recited by claim 1. The Examiner points to Joshi Col. 8, lines 24-27 for support; however, this text gives no mention or suggestion of Zinc (Zn), Calcium (Ca), or Chromium (Cr). The Examiner also points to Edelstein to provide the missing teachings. However, Edelstein describes the use of a **seed layer**. Using a seed layer with a conductive layer is different than depositing a ternary copper alloy via material, as claimed by the Applicants. Seed layer 76 (Fig. 2) and seed layer 78 (Fig. 3B) of Edelstein are deposited over the barrier layer but do **not** fill the aperture. Copper layers 60 and 56 (Fig. 2) and conductive layer 82 (Fig. 3C) of Edelstein do not have an alloy and there is no suggestion of using a copper alloy via material to fill the via.

Neither Harper nor Cunningham provide the missing teachings. Harper discloses a single alloying element comprised of aluminum or chromium. There is no suggestion in Harper to combine chromium with another element. There is no discussion whatsoever in Cunningham of

a process for manufacturing a via. Further, Cunningham does not provide any suggestion of using ternary alloys. All of the examples in Cunningham only have **two** elements and not three.

Therefore, the references, when taken in combination, fail to disclose, teach, or suggest “depositing a copper alloy via material in the via aperture to form a via, the copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)” as recited by claim 1. As such, Applicants respectfully request withdrawal of the rejection of Claims 1–9 under 35 U.S.C. § 103(a).

Claims 10-16:

In Paragraphs 9-10 of the Office Action, Claims 10-13 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Joshi in view of U.S. Patent No. 6,090,170 (“Andricacos”). Applicants respectfully traverse the rejection.

Claim 10 recites:

filling the via aperture with a ternary copper alloy via material to form a ternary copper alloy via, the ternary copper alloy including at least one element for lowering resistivity and at least one of Chromium (Cr) or Calcium (Ca);

As discussed above with reference to claim 1, Joshi does not disclose or suggest filling a via aperture with a ternary copper alloy including Chromium (Cr) or Calcium (Ca). Andricacos does not provide these missing teachings or suggestions. Andricacos does not provide any suggestion for Chromium (Cr) or Calcium (Ca). Andricacos merely teaches the use of various recipes including C, In, and Sn. As such, Applicants respectfully request withdrawal of the rejection of Claims 10-13 under 35 U.S.C. § 103(a).

In Paragraphs 11-12 of the Office Action, Claims 14-16 are rejected under 35 U.S.C. § 103 over Joshi in view of Cunningham and Harper. Applicants respectfully traverse the rejection.

Claims 14-16 depend from claim 10, which requires “filling the via aperture with a ternary copper ... including ... at least one of Chromium (Cr) or Calcium (Ca).” As discussed above, Joshi fails to disclose or suggest filling a via aperture with a ternary copper alloy including Chromium (Cr) or Calcium (Ca). Harper discloses a single alloying element comprised of aluminum or chromium. There is no suggestion in Harper to combine chromium with another element.

With respect to Cunningham, there is no discussion whatsoever in Cunningham of a process for manufacturing a via. In fact, Cunningham even states with regard to the elements used to reduce copper’s resistivity that “Interestingly, the three dopants with the least effect on copper’s resistivity -- silver, zinc and cadmium have been ignored.” (Cunningham, page 5.) Further, Cunningham does not provide any suggestion of use of ternary alloys. All of the examples in Cunningham only have **two** elements and not three. Therefore, Cunningham does not provide a suggestion for the use of the alloy of Claim 10 and in fact teaches away from it.

Thus, taken in combination, Joshi in view of Cunningham and Harper do not disclose, suggest, or teach the claimed invention as recited in claims 14-16. Applicants respectfully request withdrawal of the rejection of Claims 14-16 under 35 U.S.C. § 103.

Claims 17-20:

In Paragraphs 13-15 of the Office Action, Claims 17-20 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Joshi in view of Edelstein. Applicants respectfully traverse the rejection. Claim 17 recites:

filling the aperture with a ternary copper alloy via material to form a ternary copper alloy via including at least one of the following pairs of elements: Tin and Calcium; Tin and Chromium; Zinc and Chromium; Zinc and Calcium; Silver and Chromium; and Silver and Calcium

As discussed above with reference to Claims 1-16, Joshi fails to disclose or suggest filling a aperture with a ternary copper alloy including Chromium (Cr) or Calcium (Ca). The

Examiner points to Edelstein to provide the missing teachings. However, Edelstein describes the use of a seed layer. Using a seed layer with a conductive layer is different than depositing a ternary copper alloy via material. There is absolutely no discussion or suggestion in Edelstein of filling an aperture using a copper alloy via material including Chromium (Cr) or Calcium (Ca). Accordingly, Applicants respectfully request withdrawal of the rejection of Claims 17-20 under 35 U.S.C. § 103(a).

Claims 21-23:

In Paragraphs 16-17 of the Office Action, Claims 21-23 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Edelstein in view of Cunningham. Applicants respectfully traverse the rejection.

Claims 21-23 depend from Claim 17. As discussed, Edelstein does not disclose or suggest the claimed invention recited in Claim 17. Edelstein teaches away from the claimed invention because it teaches that the copper conductor body utilizes an alloy consisting of C, Cl, N, O and S. (See, Edelstein Col. 11, lines 22-25.) Indeed, even though Edelstein was aware of a large laundry list of elements that can be used as copper alloys, it failed to provide any suggestion for utilizing the elements explicitly recited in Claim 17 in the copper via material. Accordingly, there is no suggestion in Edelstein to use any of Chromium (Cr), Zinc (Zn), Calcium (Ca), or Silver (Ag) in the copper fill material.

There is no discussion in Cunningham of a process for manufacturing a via. In fact, Cunningham even states with regard to the elements used to reduce copper's resistivity that "Interestingly, the three dopants with the least effect on copper's resistivity -- silver, zinc and cadmium have been ignored." (Cunningham, page 5.) Further, Cunningham does not provide any suggestion of use of ternary alloys. All of the examples in Cunningham only have **two** elements and not three. Therefore, Cunningham does not provide a suggestion for the use of the alloy of Claim 17 and in fact teaches away from it.

Applicants believe that the present application is now in condition for allowance.
Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application. The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 50-2350. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 50-2350. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 50-2350.

Respectfully submitted,

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By 

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